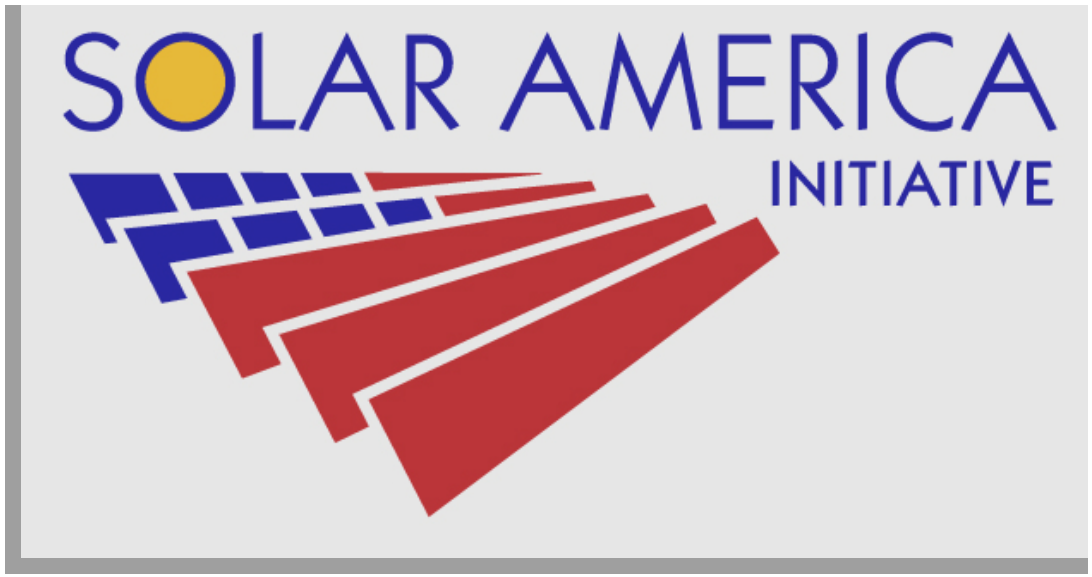
Solar America Initiative

Technology Pathway Partnerships (TPP's)



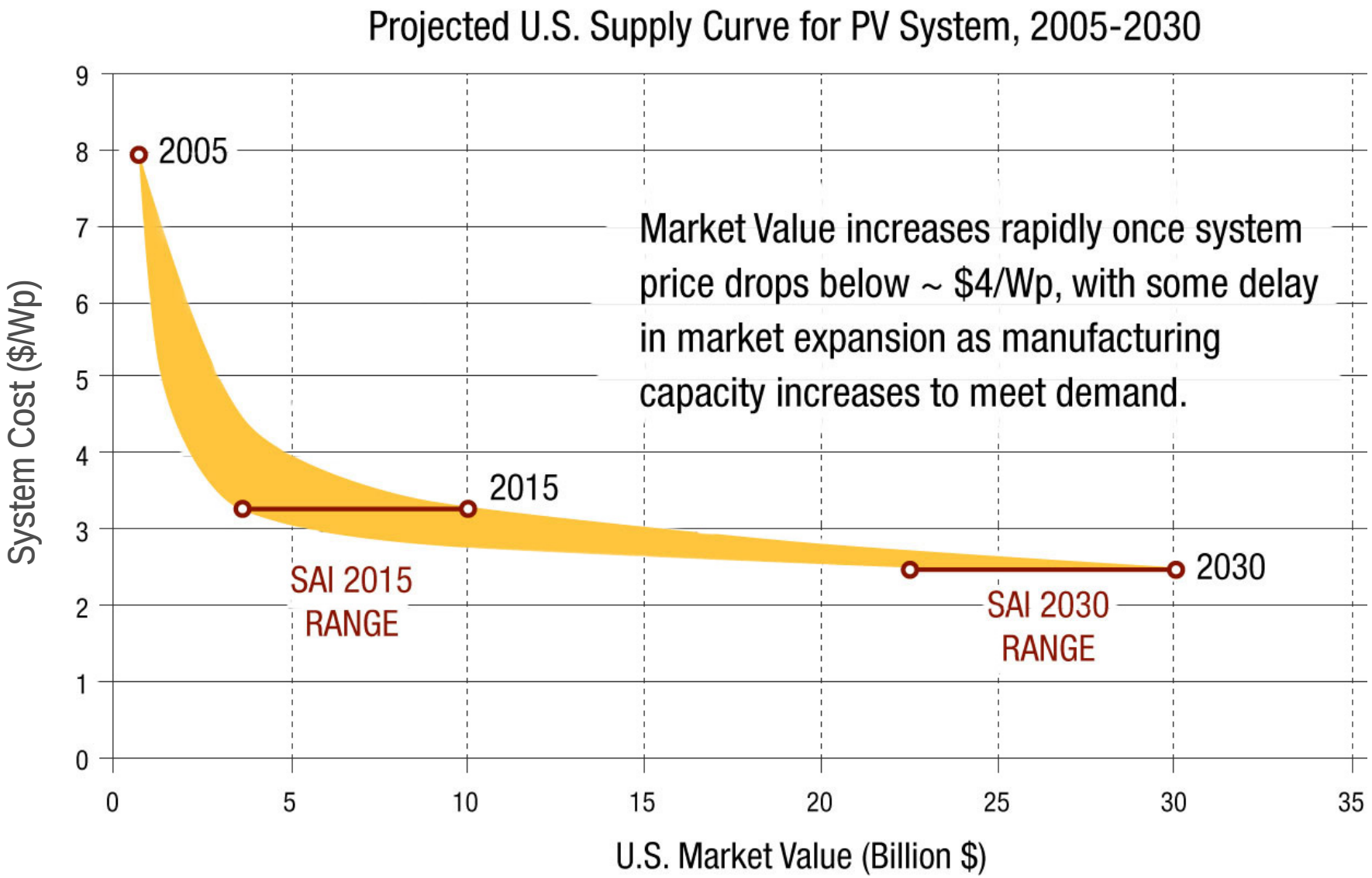
Purpose and Content

Purpose: Communicate SAI technical objectives and baseline procurement approach to prospective participants.

- Market-Informed R&D Strategy
- Program Phasing and Interdependencies
- Technology Pathway Partnership (TPP) Objectives
- Technical & Procurement (Financial Assistance) Strategy
- Stage Gate Management, Test & Evaluation
- TPP Procurement (Financial Assistance) Process
- Next Steps

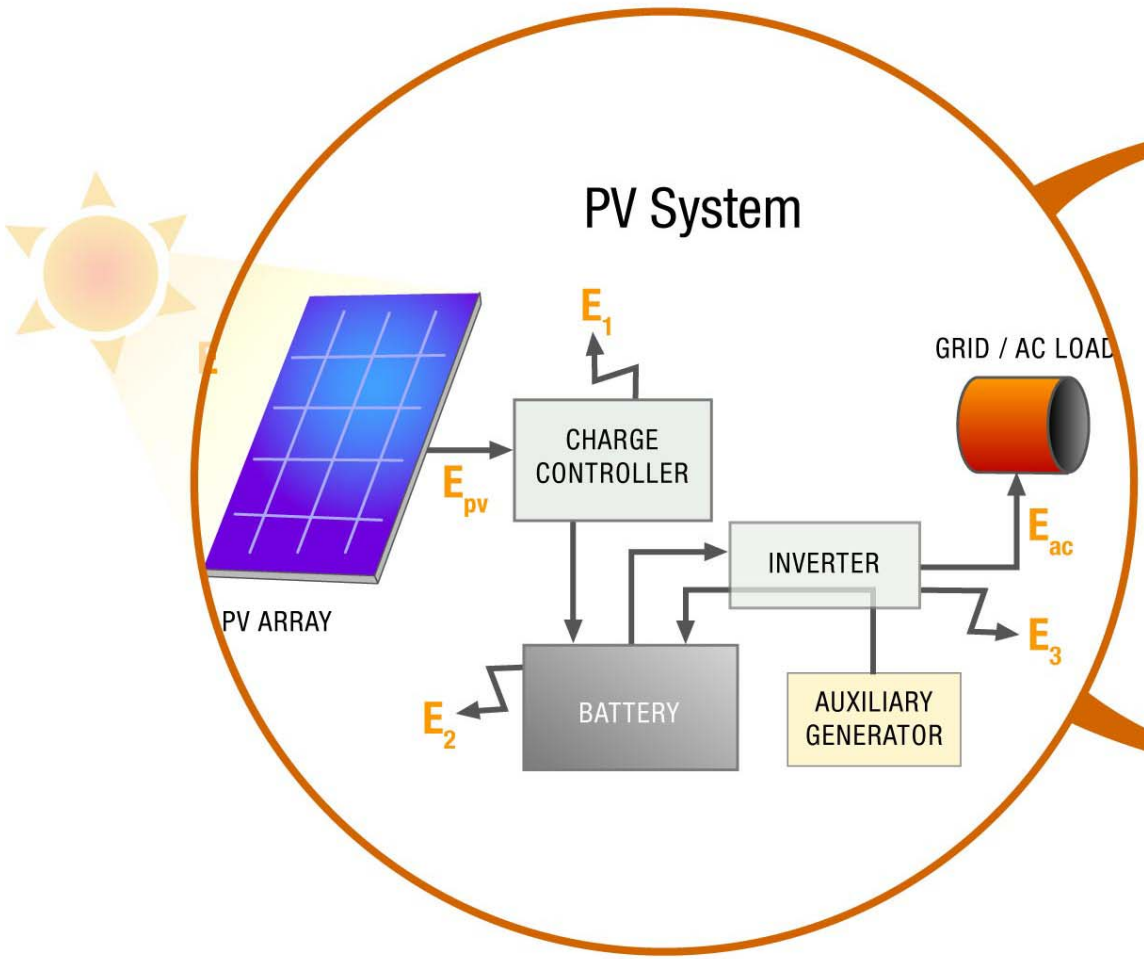
Market-Informed R&D Strategy

Not Just Profitability – PV Relevance

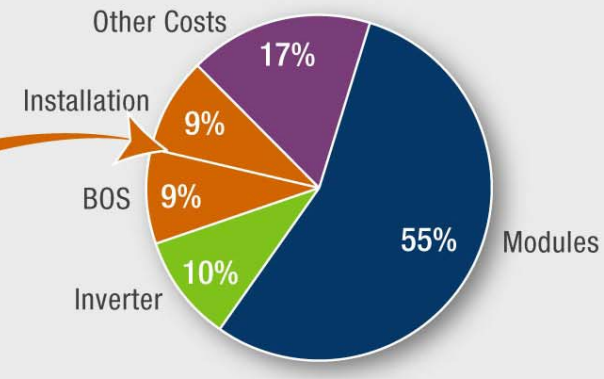


Market-Informed R&D Strategy

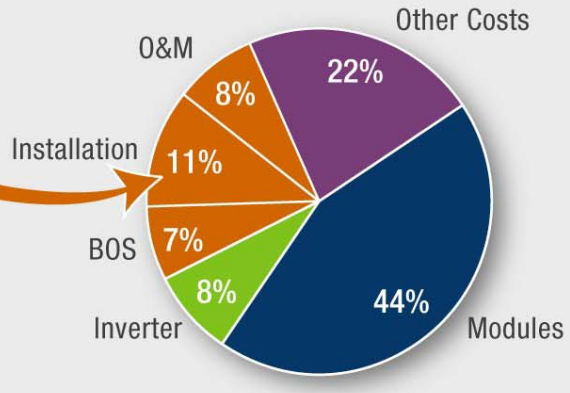
Transition to Total System Cost Emphasis



System-Level Optimization to Reduce Costs

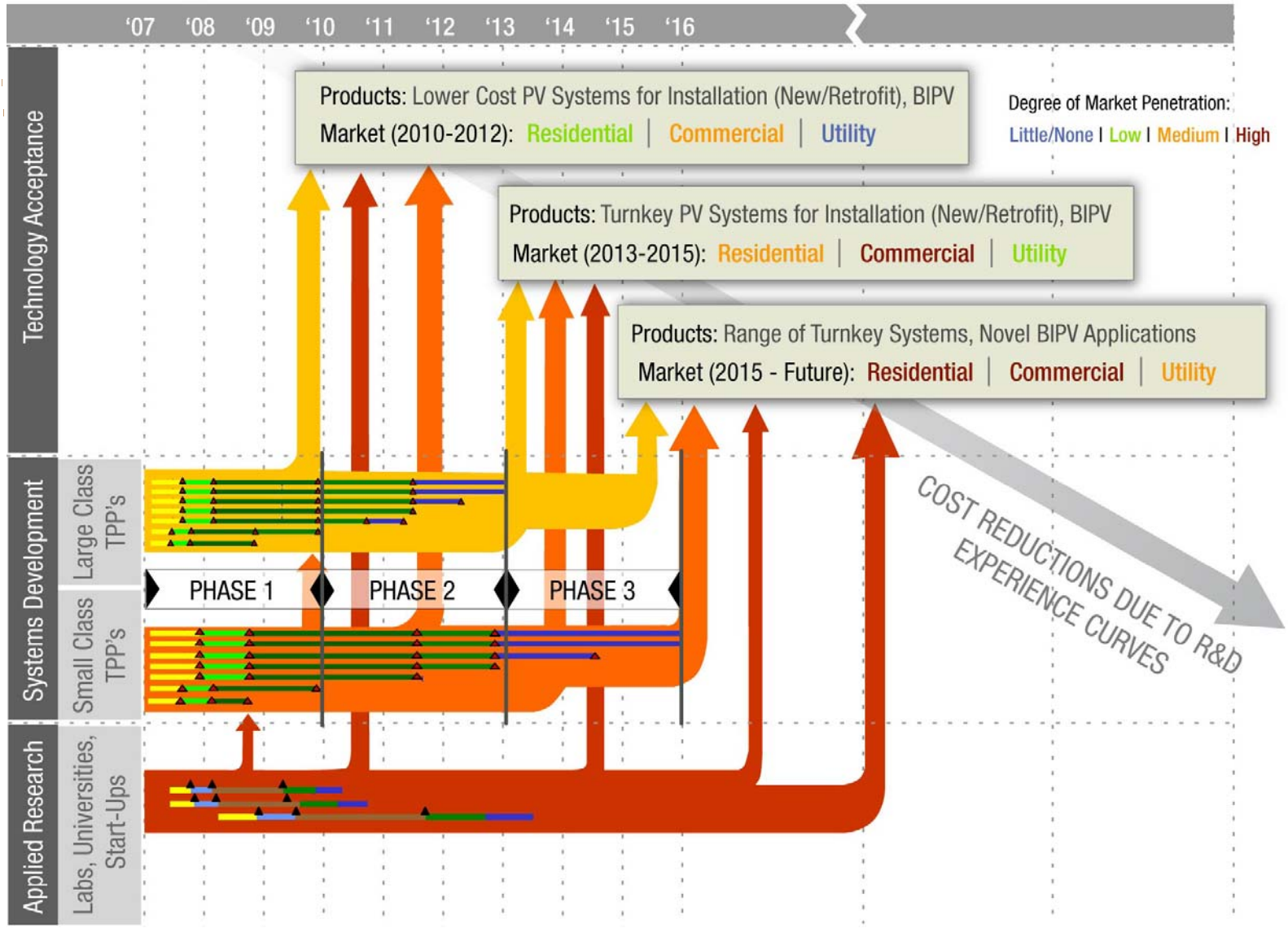


2005 Commercial PV System
INSTALLED COST (Total: $6.29/Wp)



2005 Commercial PV System
LEVELIZED COST (Total: $0.18/kWh)

Program Phasing & Interdependencies
Complementary Activities Converge



Technical Pathway Partnerships

Procurement Objectives

- **Develop Total System Solutions:**
  - Industry-led efforts deliver total system solutions for requirements of residential, commercial, or utility applications – supports tracking of progress towards LCOE at parity with grid retail prices
- **Execute Time-Phased R&D Roadmaps:**
  - TPPs will be required to develop a high level R&D and technology roadmap that achieves the 2015 goals, with significant resolution in the plan for the first three years
- **Encourage Collaborative (Value-Added) Teaming:**
  - Create industry-led teams (TPP's) composed of multiple private/public companies, universities, and National Laboratories (non-NCPV)
- **Support the Diverse U.S. Industrial Base:**
  - Structure TPP solicitation to facilitate participation from small and large firms with promising technologies
- **Preserve Flexibility:**
  - Plan for 3-Phases of SAI R&D activities (07-10, 11-13, 13-16)

Technical & Procurement Strategy

Baseline: Systems Teams (2-Tiers)

- **Two Classes of Systems-Oriented Teams**
  - Addresses present industry structure/maturity with 3–6 awards in each class
- **Phase 1: R&D Project Duration of 3 Years (2007-2010)**
  - Large Class – $60M Total Project Value ($30M DOE Award; $30M Cost Share)
  - Small Class – $30M Total Project Value ($15M DOE Award; $15M Cost Share)
  - Down-select following intermediate Stage Gate (After 16-18 Months)
- **Teams must address all elements of the PV system value chain**
  - Select specific components/sub-components for R&D, based on LCOE impact
  - Use commercially-available components where cost-effective
  - Team members performing R&D must have current capability
- **Teams submit roadmap to systems meeting SAI 2015 cost goals**
  - Includes performance/cost parameters for 2006 Benchmark, 2010, 2015
  - Detailed Statement of Objectives & Project Plan for Phase 1 (2007-2010)
  - “Technology Roadmap” for 2010-2015 is logical, but less detailed
  - Scope of Phase 1 project may include R&D for post-2009 commercialization

U.S. Department of Energy
Energy Efficiency and Renewable Energy

Baseline Partnership Activities

Systems Teams Optimize Designs, R&D

Technical Improvement Opportunities		Metrics			
TIER 1 TIOs	TIER 2 TIOs	Performance	Cost	O&M	Reliability
Modules	Module				
	Absorber				
	Cells and Contacts				
	Interconnects				
	Packaging				
	Manufacturing				
Inverters & BOS	Inverter				
	Inverter Software				
	Inverter Components/Design				
	Inverter Packaging/Manufacturing				
	Inverter Integration				
	Other BOS				
Storage	>>Under consideration<<				
SE&I	Systems Engineering & Integration				
	Manufacturing/Assembly				
	Installation/Maintenance				

- Teams will target selected components for R&D, based on analysis of impact on total system performance.
- Teams demonstrate new manufacturing approaches for selected components.
- Teams deliver full system for test, built from newly-developed and/or commercial components.

RED indicates high-impact opportunities. **YELLOW** indicates moderate-impact opportunities.

TPP Systems Team "Roadmap"

Concurrent Development to 2015 Goals

Residential System Element	Unit	2010 Target Value	2015 Target Value
System Location		Phoenix	
System Size	kW	4.56*	5.92*
Performance Parameters			
Modules			
Efficiency	%	16.0	20.0
Power Rating	W_{pdc}	114**	148**
Number of Modules	#	40	40
Inverter			
Inverter Size	kW	4.56	5.92
DC-AC Conversion Efficiency	%	96	97
System Level			
System Derate	%	5	5
Annual System Degradation	%	1	1
Cost Parameters			
Module	$/$W_{pdc}$	2.20	1.25
Inverter	$/Wp	0.69	0.30
Other Balance of Systems	$/$W_{pdc}$	0.40	0.33
Installation	$/$W_{pdc}$	0.57	0.42
Other*	$/$W_{pdc}$	1.14	1.00
TOTAL INSTALLED SYSTEM PRICE	$/$W_{pdc}$	5.00	3.30
Reliability and O&M Parameters			
Inverter Lifetime – Replacement Cycle	Years	10	20
Module and Overall System Lifetime	Years	35	35
O&M Cost (not including inverter replacement)	% installed system price	0.3	0.2
CALCULATED LEVELIZED COST OF ENERGY	$/$kWh_{ac}$	**0.15**	**0.09**

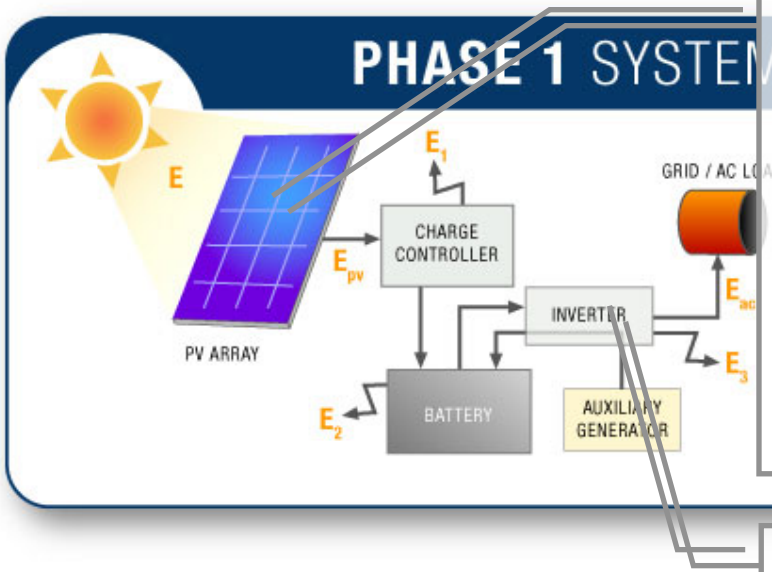
*System size increases because module performance improves, where the number of modules in the system is kept fixed

**Module output increases because module efficiency increased, where the module area is kept constant

- Roadmap identifies various R&D tasks that can "squeeze" cost out of the PV system value chain (TIO framework)
- R&D tasks are identified and prioritized, based on expected correlation with 2010 and 2015 target values specified in Application
- Phase 1 project scope is most detailed segment of roadmap with goal of delivering improved prototype product(s) for subsequent commercial launch

TPP R&D Activities

Multiple Solutions, Spiral Development



Module: Phase 1 - Primary Emphasis

TASK: Test ~ 3 new absorber deposition methods

TASK: Investigate device performance change with 2 new flexible substrate

TASK: Conduct accelerated test of module reliability with selected deposition method, substrate

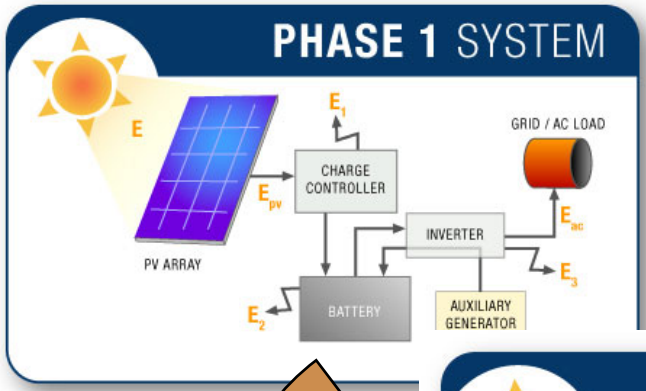
Inverter: Phase 1 – Software Development, Materials Science

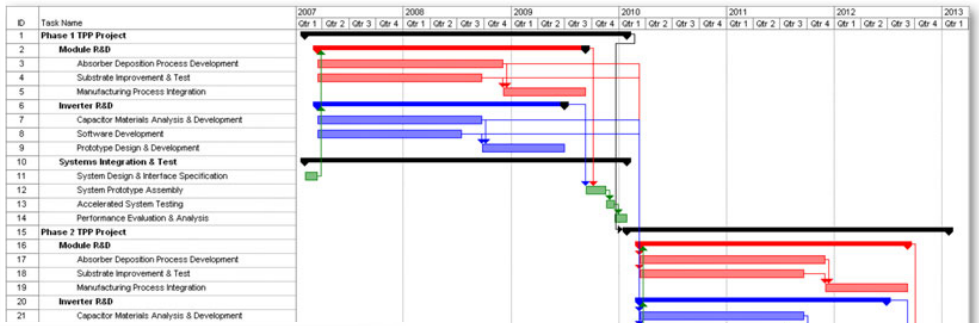
TASK: Develop new SW architecture that permits interface to building demand response systems

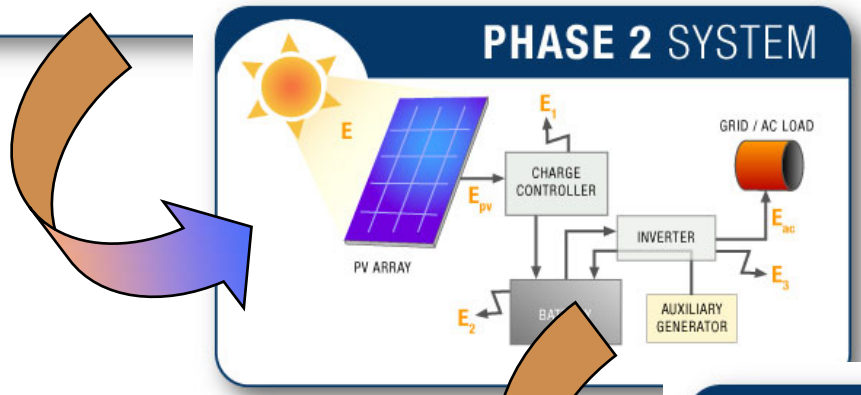
TASK: Identify new materials chemistries, investigate manufacturability for new capacitors

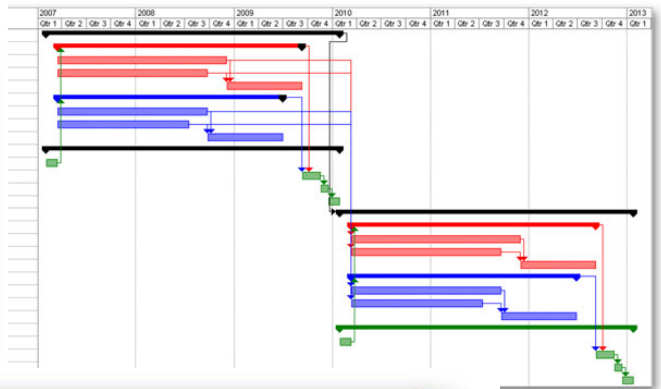
TPP R&D Activities

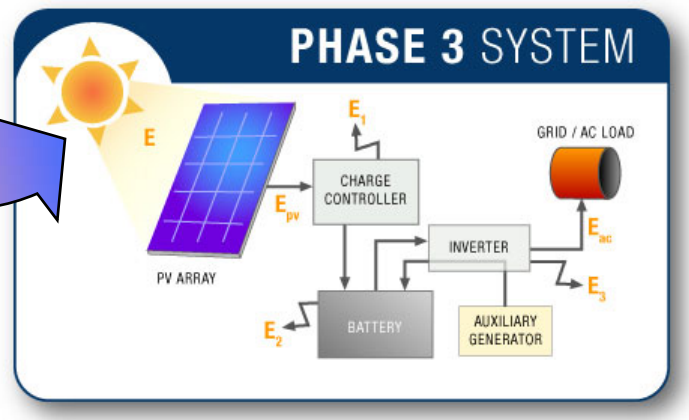
Multiple Solutions, Spiral Development







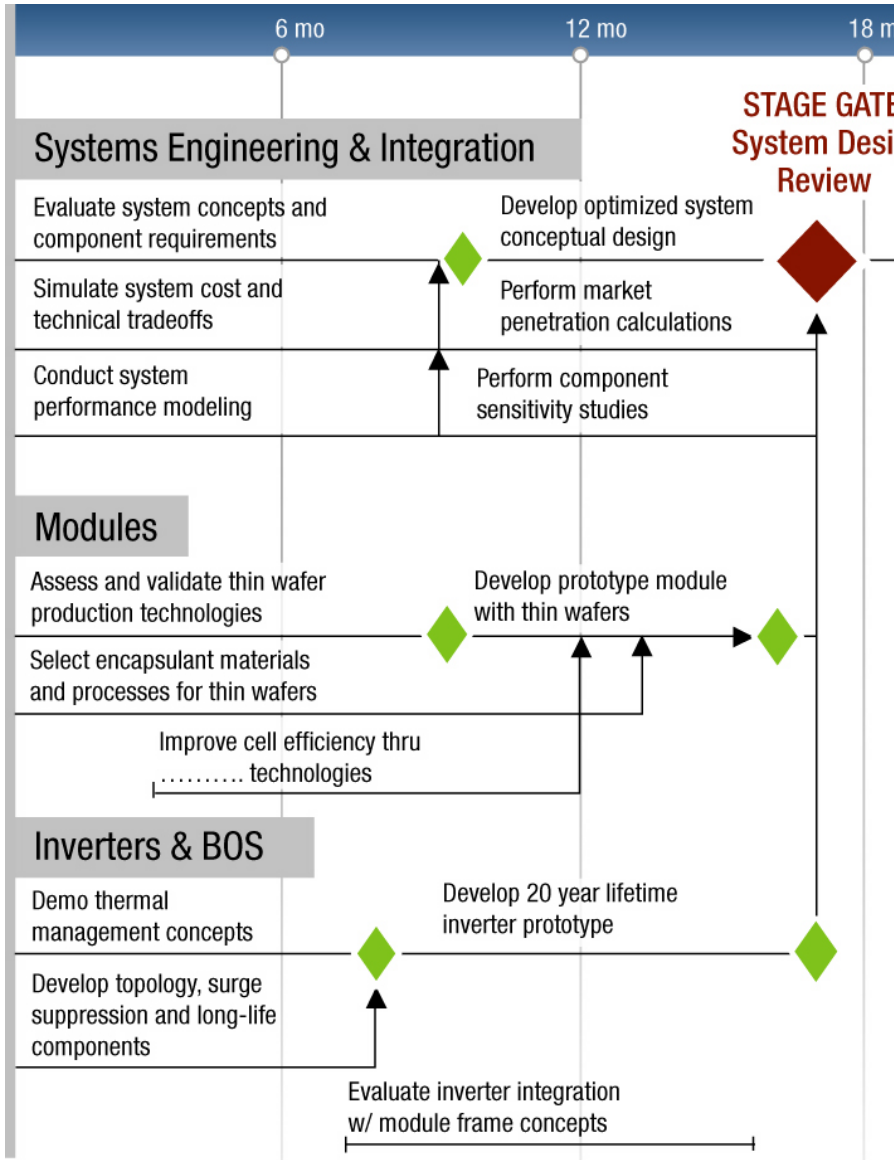




- New sub-component technologies and R&D tasks from each Phase feed into system configurations in subsequent phases

TPP Project Scope/Schedule

Aligned R&D Activities, Stage Gates

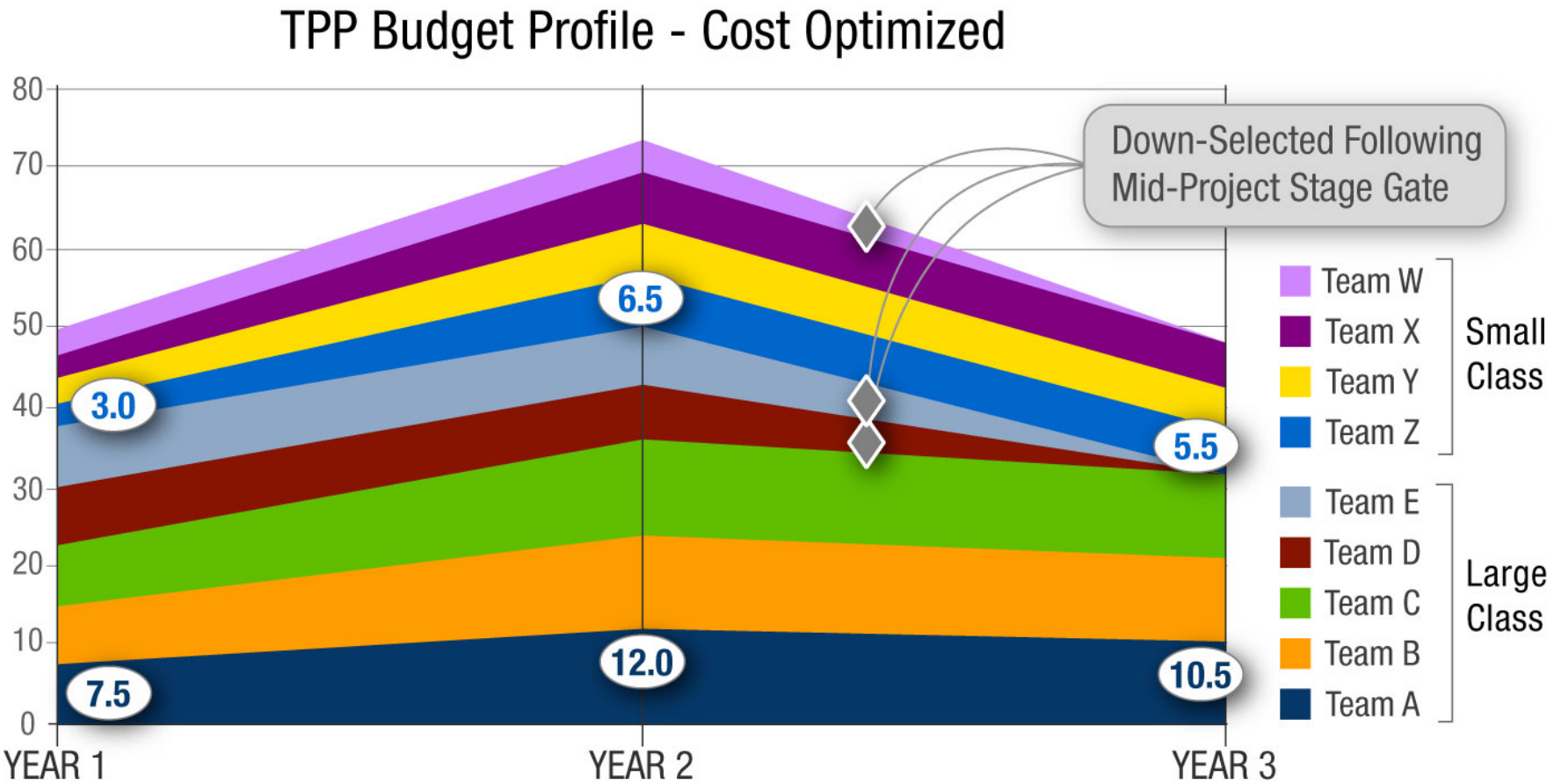


- TPP Project Plan must include milestones and deliverables, aligned with at least 2 Stage Gates (within DOE Stage Framework)
- Technical "critical path" identified, with risk mitigation
- Key critical path items will naturally form the gates, at which decisions will be made regarding the plan (Continue, Stop Work, "Recycle")
- DOE will make down-selections after mid-term Stage Gate review

TPP Phase 1 Plan & Budget

Funding Phased for PD Lifecycle, Down-Select

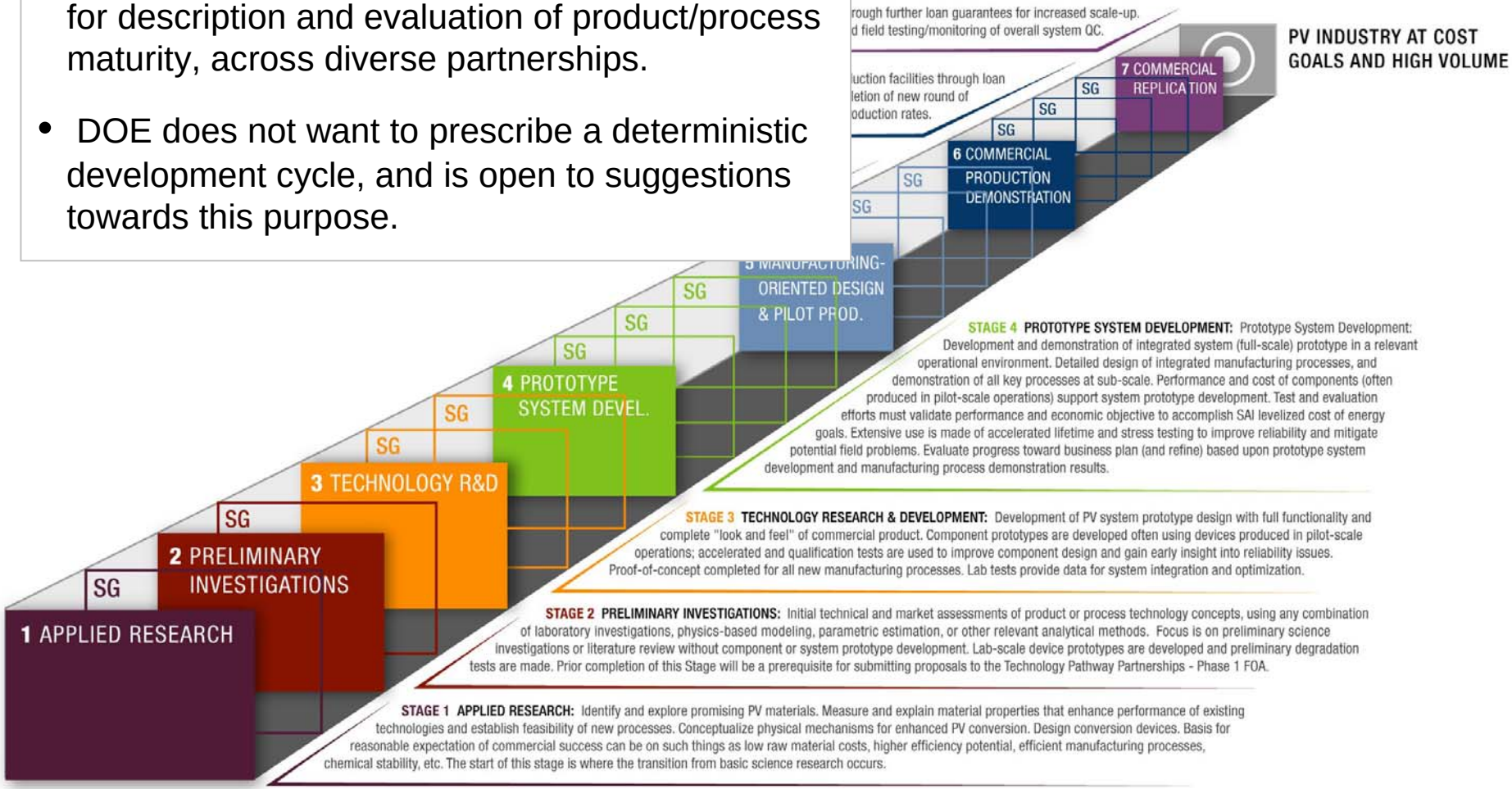
Notional - For Comment



Stage Gate Management

TPP's Tailor SG Framework to Project Plan

- DOE's intent is to provide common terminology for description and evaluation of product/process maturity, across diverse partnerships.
- DOE does not want to prescribe a deterministic development cycle, and is open to suggestions towards this purpose.



Test & Evaluation

TPP's Tailor SG Framework to Project Plan

- TPP Project Plan in application will include protocols sufficient to conduct credible, independent evaluation of deliverables/milestones.
  - If DOE-funded facilities/protocols are not sufficient to evaluate unique deliverables, alternative protocols must be specified.
  - The SAI TPP FOA will identify protocols for handling of proprietary data.
- DOE-SETP will review and approve expected test protocols and documentation, in the negotiation process prior to award.
- DOE/NCPV will maintain a master schedule for TPP and DOE program internal T&E activity, including required DOE "core" funding.
- The DOE will continue to fund core T&E activities (e.g. NREL Measurement & Characterization, RES) – for the *entire* US PV community, independent of specific TPP contracts (TPP's a priority).

TPP Procurement Process

Application Content Requirements

- **Statement of Objectives (Integrated Systems Approach):**
  - Market analysis for targeted product applications (incl. system requirements)
  - Product research & development roadmap to 2015
  - A manufacturing process & supply chain roadmap to 2015
- **Implementation/Project Management Plan:**
  - Detailed description of Phase 1 tasks – in a TIO-based work breakdown structure, identifies organizational assignments and cost estimates
  - Resource-loaded integrated master schedule – including critical path (milestones), tailored stage gate commitments/deliverables
- **Qualifications and Resources:**
  - Description of technical capabilities – key personnel, facilities, equipment
  - Relevant past performance and current business operations
- **Business Plan:**
  - Plan describes how collaborating team will manufacture, integrate, distribute, market, and deploy systems in the commercial market place
  - Supply chain analysis (bill of materials) addresses all major manufacturing costs and other operational factors

Next Steps

TPP Planning & Procurement Sequence

- Receive stakeholder input via TEM breakout sessions
- Receive stakeholder input via NOPI responses
- Formulate SAI Posture Plan
  - Technical & Procurement Strategy
  - Stage Gate Management Approach
  - Test & Evaluation Approach
- Formulate and issue Funding Opportunity Announcement (FOA)
- Provide needed guidance to FOA application development
- Receive, evaluate, select applications to FOA
- Commence negotiations with selected TPP teams
- Award TPP cooperative agreements, initiate R&D